Public Land Management
Agencies Bark Beetle and Lodgepole Pine
Workshop Notes

Sponsored by the USDA Forest Service (USFS) Colorado
Bark Beetle Incident Command Team
And the Rocky Mountain Research Station (RMRS)
June 13-14, 2007
Apache/ Navaho, Indian Peaks Lodge
Meadow Lane
Snow Mountain Ranch, YMCA of the Rockies
(12 Miles northwest of Winter Park, Colorado on US Hwy 40)
http://ymcarockies.org/home/our-locations/snow-mountain-ranch
800-777-9622

Lodgepole Pine Ecology:
Lead Panelist- Mike Ryan (RMRS)-Ecologist
Panelist- Sheryl Costello (USFS R2)- Beetle Ecology
Panelist- Wayne Sheppard (CSU)- Retired Guy
Panelist- Tania Schoennagel (CU)- Fire Ecologist

- Introductions of Attendees
- Clint- Thank you for all the hard work from planning team
  1. Took some heat for keeping workshop small, exclusive
  2. Want to open workshop in fall to public
  3. Want to open workshop to a conversation, discussions

Mike Ryan- Lodgepole Pine Ecology in the Wild

- Help from Bill Romme- CSU, Dan Kashian, Wayne State U.
- Strife of Lodgepole Pine
  - Quotes from Arapaho-Roosevelt National Forest, and Dan Binkley
- Agenda
  - Life cycle of LP forests
  - Compare with Ponderosa Pine
  - Forests and MPB
  - Fire and Beetles

- Life Cycle- Death, stand replacing fire every 200-350 years
- Life Cycle- Rebirth, serotinous cones open after fire and produce seedlings
  - Early cone production (<15 years) helps fill in gaps
  - Heat up cones in microwave!!!

        - Born to reproduce
        - Other species- snow brush and reedgrass
        - Young stands, 10 years old, densities vary
        - Example- Yellowstone
        - Regeneration common
    - Young stands, vary densities
        - Self thinning in denser stands
        - Trees killed in fires decomposed
    - Middle Age 100-175 years
        - Self thinning complete, little dead wood unless stand is dense
    - Old Age- >230 years
        - Attacked by beetles, new regeneration, crowded
    - Death- Fire
    - That's the natural cycle

    - Compare LP to Ponderosa Pine
        - Historically open woodlands
        - Very different ecosystems
        - Burned by light surface fires 10-30 years
        - Cones destroyed in PP fire, crown fire, poor or no regeneration
        - Fire management may reduce risk of crown fire
        - LP has dense stands, longer fire regime

        - MPB native, historically active, outbreaks common in past
        - Don't have a good idea- how it compares to past outbreaks
        - Only have past 100 years of research, don't have tools to go back in centuries to research
        - More severe? No recent cold winters...
        - A lot of LP susceptible to MPB

- Effects of Bark beetle Outbreaks in LP Forests-Wisdom
- Beetle outbreaks destroy forests
- Create huge fuel loads for bad fires

- Study by Bill Romme: Forest productivity reduced temporarily after bark beetle outbreak, but recovers fast
- Beetle caused mortality accelerations succession by killing dominate tress

- Outbreaks create fuels for bad fires
- Not always a bad thing...
    - Crown-fire ecosystem
    - Normal
    - Rapid recover
    - Not ecologically bad
    - BAD threat to houses and property in WUI

        - Risk of fire goes down after ...

    - Conclusion
        - Large fires threat to communities
        - True now, always will be true in future
        - Lifecycle starts and ends with crown fire
        - Lots of fires not part of ecology
    - MPB natural part of ecosystem
    - MPD don't last forever
    - Lots of work form many researchers

Sheryl Costello- Entomologist

- FHM Activities
    - Training
    - Site visits
    - Management recommendations
    - Administrative studies
    - Forest plan input and review
    - Insect and disease
- Overview
    - Beetle ecology
    - Dynamics of outbreaks
    - Areas affected
    - Related study
    - Final thoughts

- Alaska- outbreaks, widespread in west, we are not the only ones!
- *Dendroctonus ponderosae*
- ¼ inch
- Thousands

- Research used to think life was a 2 year cycle, but it is actually a one year cycle

Life Cycle:

- attacking adults fly in July- August
- lay eggs, larva hatch, feed
- winter, don't feed, antifreeze, -29° it can handle, underneath bark
- pupa
- emerge in following summer
- Make tunnels in bark
- Pitch tubes

- MPB native, pockets of trees through out landscape normally

        - Increase in trees with thicker phloem
        - Larger diameter
        - Denser stands
        - Hot/dry conditions

- Age of LP- susceptible age range

- Predators- clair beetle, attack larva of beetle, flies- deposit under bark, that attack eggs

- Aerial survey photos
        - Mapping damage
        - Sketching mapping tools
        - 1999 aerial survey of state, northern part of state, picture compared to 2002- intensified, exploded
        - old, new clear cuts patches still alive
        - kill small trees
    - Good things about Beetle
        - dramatically changes stand structure
        - increases forage for deer and elk
        - woodpecker food
        - negative impacts on other species

    - changed fuel conditions, increase crown and surface fires
    - mortality and fire implications study
        - describe stand conditions, research
        - took points in both infested and non, radius plots
        - Results: no difference between uninfected and infested in fuel loading
        - future increase over 50/tons/acre in 12 year projections

    - Fire Implications
        - Surface ,passive, active, crown- stages
        - Crown fire goes down over time
        - Increase in passive fires

    - Conclusions
        - Projected increase in fuel loading
        - Dependent on weather
        - Time since beetle outbreak
        - Stand structure
    - Variable across landscape
    - Management
        - Preventative spraying, valuable trees
        - Stand management in desired areas
        - Thinning, multi-age stands
        - Still attack thinned eventually

- Summary
    - Many tree killing beetles are native
    - Outbreaks natural process
    - Climate change- if gets warmer, gets worse
    - Dramatic changes in high elevation forests

    - Contact Info
    - www.fs.fed.us/r2/fhm

Wayne Sheppard- Disturbance Ecology of LP: Points to Ponder

- LP- high altitude, not climax species, cold and wet, associated with many different species, not pure stands

- Characteristics of LP
    - Seriotiny varies, one shot deal- all seeds in one cone
    - Planting may be required to regenerate
    - Mechanical or chemical prep may be need to establish seedlings
    - Natural stocking densities are not economically possible
    - Sun-loving, grows in open
    - Rapid early growth
    - Grows in dense stands <100 years
    - Small diameter with out management
    - Shallow rooted, blow over
    - Susceptible to mistletoe
    - Don't destroy forests, they rearrange them, spatial and age class point of view
    - Succeeds to spruce and fire
    - Process is accelerated by MPB
    - Require active management to establish LP component, projected years from now, almost non-existent
    - Compete with aspen, aspen is winner, and shrubs also beat it out
    - Long interval- stand replacement
    - Fire return interval may not be out of balance, but distribution of age class on large landscape different than in past
- Many fires during mining area, subsequent fire suppress resulted fin more contiguous mature trees in landscapes all susceptible to MPB
- Distribution will be different

- ROLE OF Management in LP affected by MPB:
    - Manage for what?
    - Plant new LP?
- Manage to break up continuity of age class structure and fuels at landscape scales?

- How to manage stocking of LP for multiple resources values?
- Intro to alternate vegetation types and succession pathways into landscapes?

Tania Schoennagel- Fire Risk and MPB Outbreaks

- Recent Forest Insect outbreaks and fire risk in CO forests: synopsis of relevant research
- Management involves so many things
- Scientists focus on one aspect– what are the ecological effects?
- Disclaimer

- Overview
  - Likely causes of recent outbreaks?
  - Consequences of these?

- Likely Causes of Outbreaks
  - Climate, drought, stressed trees less resistant to attack, warmer winters, less mortality
  - Forest characteristics- species, age, tree size, density, tress resistance, food supply

- Has fire suppression to contributed to MPB outbreak?
  - Suppression of fires, equals denser stands, more susceptible- Not Supported
  - Low severity fire regimes- increase in stand density
  - High severity fire regimes- little change in last century, already dense forests

- Has fire suppression changed age class of forests? No, long fire intervals anyway

- Large crown fires- occur infrequently, impossible to suppress, big influence on current age of forests

- <5% of wildfires account for >95% of the area burned

- Dense forest and large crown fires are business as usual

- Main Influence- not fire suppression, extensive burning during extreme drought and late 1800's

- Fires resulted in extensive stands of relative similar age

- Consequences
  - 2 main sources of info

    - fuels data from beetle affected stand
    - historical data

- Fuels Data- continuity between surface fuels and canopy fuels (ladder fuels or crown base height)
    - Fuels, mass- canopy bulk density and continuity

- Changes in fuels after outbreak
- Lives fuels converted to dead
- Dead canopy shift to surface fuels as needles branches and trees fall

- Should reduce ladder fuels, canopy bulk density and crown cover, reduce risk of crown fire

- Fine fuels spread fire, large fuels do not
- Large severe crown fires, are typical

- How Things will be changed- needs to be tested
    - Public expects beetle increase to stay high,
    - Only happens in extreme drought, risk small
    - Reduced crown fire risk, slowly die down

- Historical Data
    - Spruce beetle outbreak in 1940's
    - Fires occurrence not higher after outbreak

- Stand structure and forest cover type best indicators

- Insect outbreaks did not affect severity of 2002 fires
- Interpreted cautiously

- Yellowstone study: 11% more likely to occur in areas that were damaged by MPB in the 1970's
- No change in fire occurrence in response to outbreak in 1980's
- Only 6 studies we can use, don't all say the same thing, don't have large outbreak research to draw from

Questions and Answers

- Clarify severity and risk to public, we are confusing them, we need to as a group define these terms and be clearer on the concepts

- Needles fall- goes down, needles stay on for 3 years, affects aesthetics
- Succession- if there is shade- Spruce/fir need to come in

- In terms of succession, how long are cones on ground still usable? Not long

- Hazard trees, fuels- once tree dies, what is susceptibility of blow down? Is it better to leave dead trees standing in clusters than taking down trees and making other trees susceptible to blow down? Blue stain increases blow down, all trees susceptible to blow down, blue stain accelerates the rotting process

- Age class distribution- has a strong influence, all agree... disagreement on if it is normal now or not...

- We have suppressed small fires, that could have become big, should we suppress fires now? Changes age classes, if we put out small fires, we will only have large, important fires... should we suppress?

- Research going on in Saskatchewan, if we change the patch size? How does that affect?

- Trend- predicted for future: Time level oversimplified?

- Trend of drought, when does that end? Just a hypothesis... How long needles are on trees, 1-3 needles, stand based, could widen if its landscape based.

- Time correlation between drought and outbreak, La Nina, and El Nino, have affects. 10 year range predicted, maybe longer. Is peak real (red-needle on trees-peak)?

Fire Behavior

Lead Panelist- Kevin Ryan (RMRS)
Panelist- Paul Langowski
Panelist- Bob Means (Wyoming BLM)
Panelist- Doug Stevens (NPS)

Kevin Ryan- Dynamic Changes in the Fire Environment Associated with Beetle Attack

- Focus on the process... ecology is local
- Fire Environment
  - Varies in time and space
  - Weather-wind, humidity, drought
  - Fuels, vegetation, canopy, ground, surface
  - Landform-Terrain, slope, aspect, elevation, hill, slope, drainage
- Primary effects on beetle, wind, fuels
- Veggie Structure- quantity, distribution, arrangement of live and dead trees, under story, woody debris, litter, etc.
- Environment changes, so does fire behavior, and effects

    - Crown fire= snags
    - Active surface fire=scorched lower needles
    - Creeping surface fire= snag
- Direction of Fire Spread
    - Backing fire, flankfire, headfire
    - Increasing fireline intensity
- Archaic
    - Rate of spread (ROS)
    - Resistance to control (ROC)
- Modern
    - Fuel model, ROS FI (flame intensity), FL (flame length)
    - Modern fuel maps do not explicitly map ROC

- Fire potential varies with Stand density, the higher it is, the higher the risk
    - Denser fires carry fire for fewer days
    - Diffuse Mortality
- Pre-MPB Attack- Green Forest vs. red needles
    - Hydrology review
    - Fuel moisture, canopy decrease, surface increase
    - Wind- normal
    - Light- canopy interception
    - Surface interception
- Pay more attention to resistant and control, issues with snags
- Extreme soil heating from log burn-out, logs contribute to extreme fire behavior and resistance to control
- Temperature Effects on Plants and Soils
- Fire Severity Matrix- Erosion potential goes up with burn severity
- Fire Potential- the amount of work someone has to do to manage fire
    - Stand structure, forest succession, etc
    - On average, everything equal, decrease 3-5 years, up to 15 years
- Potential analysis tools

Bob Means- Fire Behavior Risk and Hazard

- Bookends- large extreme fires, or small fires
- Fire Behavior Basics
- Stand replacement fires- NOT crown fires
- Causes
    - Topography
    - Weather
    - Fuels
- Topography
    - Direct- wind, steep slops
- Weather
    - Fine fuels growth, amount of timing precipitation and dry vs. wet lighting
    - Drought periods, climate change =long term veg change

- Acres of aspen in lower end, even though they are in the Historic Range of variability
- Fuels- stand structure, stand age, more prone the older they are

- All or nothing'
- Succession rules
- 1. Dominant seral- vigorous understory spruce/fir
- 2. persistent dominant with little shade tolerant species establishment

- Young stands, less than 70 years ten to exhibit low fire behavior unless, drought and understory of shade tolerant species, subalpine and other fires ladder fuels

- Ecological State- Lodgepole in with in region in natural condition- his opinion
- Because system is normal, must look at risk and hazard as major factors in the decision making process

- Risk Vs. hazard
    - Risk- change of fire starting as determined by the present and activity of causative agents, lighting, humans
    - Hazard- any real or potential condition that can cause injury, or damage to equipment or property, in clues forest structure, age, condition, values at risk including watersheds, WUI

- Both vary temporally, and spatially
- Dynamic not static
- Can be seasonally, or long periods of time

- RISK- canyon change the probability of wildfire occurrence?
    - Human caused factors- in limited fashion, yes
    - Prevention, education
    - Aggressive pursuit of damage in humans

- HAZARD- can you mitigate the fuel hazard across the entire landscape? Thus change the probably of spread, reduce behavior, and reduce threat? No, why, money, funding, etc.

- Values at Risk- Probably of event with negative effects as defined by humans
- Initiate effective actions, correctly identify all of them
- Involves working with your local, state and other resources

- How to Mitigate?
- Identify, prioritize, take action

- Tools To Assist You
    - CWPP

    - Flammap-
    - Farsite
    - Landfire, GIS, Weather Data Layers

- Potential types of stand structure modification 1
    - Must evaluate entire stand, not just red needles
    - Sage, MBP, spruce fires, aspen, large dead and down component in fuels

- Potential types of stand structure modification 2
    - modify aspen stands, everyone likes that

- Potential types of stand structure modification 3
    - Use point protection techniques around values at risk-

- Focus, communicate, educate, and mitigate

Paul Langowski

- Insect fuels, profiles, etc.

- Differences between stand structure and fire behavior
    - Density, composition, amount of fuel, arrangement, moisture, prevailing, etc.

- Crown Fire Hazard
    - Initiation
    - Spread

- Stand attributes that act as important

- Surface fuel condition
- Crown base height
- Crown bulk density

- All can be altered by bugs
- Standing fuels, duff, down woody fuels, ladder, herbaceous, microclimate

- Fire Hazard
    - Ignition, receptive fuel bed, fire weapon, need to have all 3, or won't work
    - Bi-modal fire hazard
    - Initial increased fire hazard- 1-3 years while needles are on trees
    - Surface fire hazard, as needles come to ground

- Much lower wind speeds, transition to crown fire- on graph
- Stand is more susceptible for crown fire

- 15-30 years- ladder fuels, surviving over story
- Transition to crown fire, even easier

- Keep in mind- how is fuel bed, how compact, deep, etc..

- No wind- flame length, more fuel loading, harder it is to construct line

  - Hazardous fuels treatment goals-
    - Reduce flammability
    - Intensity
    - Potential for creating fire brands and crown fires
    - And increasing fire fighter safety and effectiveness

  - Treatments
  - Ignition zone with in 200 feet, not sufficient to reduce threat to neighborhoods and individual structures
  - Treatments located upwind, and adjacent to high value resources may be sufficient
  - Surprises are inevitable. With surprise comes necessity to improvise, make do and with the hand your dealt, adapt, think your feet, contain and bounce back from unexpected events

Doug Stevens- Fire Behavior

- Compact fuel bed, arranged wrong

- Arranged right, not compacted, good fire

- Post MPB-
    - Ability of high intensity fire to spread rapidly- red needles increase that, rapid spread
    - For one tree or for a stand? A group of trees that turned red at one time
    - Combines a mix of all, green, red and no needles,- peak lowers, and grows wider, because it lasts longer
    - If we leave stand alone, slowly rises on ability for high intensity
    - Extremely high resistant to control- hard to dig line, etc.
    - Bonfires of fuel- soil heating

Questions and Answers

- All these different research models- not a lot of science yet, we are using predictions, and experiments, need to educate public, not all exclusive, can use them at different points in the landscapes at different times, possibly. There is so many variables

- What capacity do we have to make a difference with in the next 3 years?

- What are the most viable management options? Salvage- could make problem worse, we need to pay attention to the fuels profile, not just salvage, or a management option.]

- Spruce beetle and other bugs are also increasing... a whole different story, could get going and have the same potential impacts

- Dillon district- assessment, 130,000acres of lodgepole infested, treating less than 10% after, we need to focus on the fire science... how will it behave now? Depending on fuels?

- 400,000 acres grand county- 180,000 infected 20-25,000 treatments on land

Watershed

Lead panelist: Chuck Rhoades (RMRS)
Panelist: Kelly Elder (RMRS)
Panelist: Rob Hubbard (RMRS)
Panelist: Deborah Martin (USGS)

Kelly Elder – Water and the Mountain Pine Beetle

Outline of panel discussion

Forestry practices and water yield in subalpine zone with and without beetles
Value of long term data
Future Expectations

There are <u>TWO major players in subalpine hydrology</u>

- Snow
- Trees

SNOW:

- Approximately 2/3rds of precipitation comes from snow & leaves as snowmelt
- snow acts as a natural storage reservoir
- snow has a natural residence or lag time in downstream delivery
- losses because of the nature of snow

TREES:

- Hold snow on site, therefore altering redistribution
- Change local energy balances
- Intercept snowfall
- A portion of the snow from tree canopy sublimates (never hits the ground)
- Snowmelt recharges soil moisture, trees use the soil moisture pool for Evapotranspiration

What has been learned from previous management studies?

- **Fool Creek Study –** Classic paired watershed study
    - Objective: to determine the effect of harvesting on snow accumulation, runoff quantity and timing, and sediment production.
    - 50% of the trees were removed (clearcuts).

Results after 50 years:

- Still see a 2 inch increase in water yield
- Data suggests the hydrologic recovery period is about 60 years

The observed increase in runoff is due to:

- Decrease in tree canopy interception and sublimation.
    - Approximately 50% of snow is lost to sublimation.

- Increase in snow accumulation in cut strips because snow is not intercepted by trees
- Decrease in summertime evapotranspiration loss from trees because there are less trees on the plots after harvesting, which also leads to reduced soil moisture depletion
- Reduced soil moisture deficit

What we know from previous beetle research:

- Bethlahmy (1975) - White River National Forest
  - ~ 3 square mile basin
  - 80% of the trees that covered 30% of the watershed area were infested with beetles

- This resulted in increases in average annual water yield, low flow rate, high flow rate, and instantaneous flow.
  - 15% increase in average annual water yield
  - 31% increase in low flow rate
  - 22% increase in high flow rate
  - 27% increase in instantaneous peak flow
  - Greater than a 25 year hydrologic recovery period

Predicted beetle effects on hydrology include:

- Tree interception losses to atmosphere are still significant for trees with green needles **and** red needles, however when needles drop will get…..

  - Reduced tree interception of snowfall, therefore…
    - Decreased sublimation loss
    - Increased snowpack
  - Reduced summertime evapotranspiration (especially for dead trees), therefore…
    - Increased soil moisture
    - A significant portion of melt water is used onsite for live canopy evapotranspiration….as trees die off, this same amount of moisture would be available for runoff
  - Increased runoff
    - Probably won't be quantifiable in some watersheds, but will in others
    - Response will be related to the complex mosaic of processes and controls

- Branch stiffness and geometry might also influence interception of snowfall

Reasonable Management Practices based on what we know:

- Surface roughness is critical in snow dominated hydrologic regimes
    - Roughness helps to hold more snow on site

        - Roughness might include understory, advanced regeneration, cull, windthrow
        - As soon as snow reaches the level of surface roughness, you will get transport…..life expectancy of snow decrease dramatically
- Don't expect radical departures from historical flows
    - Existing safety factors should be fine, might increase safety factors slightly for new projects in pine dominated watersheds

How long term Fraser Experimental Forest data will contribute to beetle research…

- Long term data is critical in identifying change
- Records are valuable when used with models and process-level studies in periods with changing mean and variance
- Short term records have greater uncertainty and greater risk for misinterpretation

Meteorological data shows that in 1990-2000, temperature climbed above the minimum of negative 30°F temperature to kill beetles.

Current and Future Research

- Focusing on disturbance of beetle impact on subalpine system and impact of treatments
    - Hydrology – quantity and quality
    - Biogeochemistry – nutrient exchange
    - Sediment – treatments, roads, site prep, windthrow
    - Riparian system – coarse woody debris

Expectations for research

- Answer relevant questions as soon as possible
- Should be able to answer some process-level questions within a few years
- Physically based models help reduce uncertainty and can be used in decision making
- Use caution when examining statistical models with insufficient data

Rob Hubbard – Quantifying Changes in Forest Water Use Following MPB Infestation

Outline of presentation

- Tree and Stand Level Effects
    - Effects of MPB on tree transpiration
    - Contributions of lodgeple pine to stand transpiration before and after MPB attack
    - Understory release
- Watershed Level Effects
    - Harvesting vs MPB
    - Quantifying changes in water yield

Transpiration Studies at Fraser Experimental Forest

- Determine the relative contributions of phloem girdling and blue stain to tree mortality

    - Beetles reduce transpiration by ~50%, just 3-4 weeks following attack
- Quantify transpiration to total site water balance, looking at a young stand vs an old stand

Conventional wisdom was that you don't really see an effect (decrease) until the following year, however……

- Beetles reduces transpiration by ~50% just 3-4 weeks following attack
- MPB decreased annual transpiration by ~23%

Lodgepole pine is the largest contributer to stand transpiration in Fraser

Elsewhere in the basin (Lexin(sp??) Creek Watershed)

- From 1991-2006 – More than 80% decrease in basal area due to MPB in one stand, and ~ 45% decrease in basal area in another stand
- Data suggests approximately a 60% reduction in annual transpiration where lodgepole exists, which was also the largest contributor to transpiration before MPB

How will understory (spruce & fir) release affect water use and water yield

- Fool Creek – cut in 1958, created a substantial release for subalpine fir
    - Same growth occurred in 10 years after release, that occurred 100 years before
    - Possible implications….using more water, nutrients, etc.
    - Younger trees can use more water and the rates of water movement are higher than in older trees
    - Using data (velocities) scaled up to watershed, the potential understory release mitigated the annual transpiration loss by about 20%
    - Decreases in stand transpiration will depend on species composition and understory release

How will MPB disturbance differ from that of harvesting?

- MPB is expected to have a delayed response, because sublimation losses will still be occurring even after trees have been hit

In order to quantify mortality and changes in forest structure, visit extensive network of long term snow course forest inventory plots (plots are 10m in diameter). Use data for looking at changes in interception, leaf area, and basal area. Scale that up to watershed. Compare changes in stream flow and changes in transpiration and changes in interception.

Goal is to inform processes driving these changes and the magnitude of the changes.

Chuck Rhodes – Biogeochemical Consequences of Bark Beetle Outbreak

Outline of presentation
- What's in store for water quality?
  - MPB effects on watershed processes
  - Management response

Need to evaluate effects of MPB on a regional scale (i.e. watersheds) looking at snow accumulation, stream flow, and nutrient export; however, these process rates are slow.

Looking at a study of an *Ips* outbreak in Bavaria in Norway spruce
- 85% overstory mortality
- Large increase in nitrate leaching (which is also a potential source of water impairment); however, the study site was a fairly polluted area to begin with

Another study in red pine mortality from pine wilt
- Increase in nitrate after a 5 year lag; however, it was a lower level of nitrate, but had an extended response

Bottom line….BUGS alter water quality!

So what regulates these water quality impacts???
- Nutrient uptake
  - Very little of the nutrients actually leach out, most are taken up by trees.
  - However, with no trees, nutrient uptake will decrease and leaching will increase
    - ~ 95% will leach out and go into streams
  - Regeneration might take up some nutrients
- Nutrient Turnover
  - Also have other nutrient inputs (litter, temperature, moisture), therefore having increased nutrient production, thus increased leaching

Nutrient Turnover also impacts water quality.
- Looking at a study with canopy defoliation from a cankerworm
  - Defoliation caused green fall, which increases nitrate export…..saw effects similar to fertilizer
  - Defoliation increases soil N availability and N turnover
  - During defoliation saw the increase, but then it decreases afterwards

Similar situation occurred from green needle fall with the wooly adelgid.
- Pools of ammonium increase, which also increased the nutrient turnover

What can harvest studies tell us about MPB outbreak?
- Looking at a paired cut and uncut slopes in Fraser
  - Release of nitrate in sub-surface flows in those areas not being cut is negligible

    - In areas of clearcut, have sharp peak of nitrate export within 5 years, with a long recovery period.
    - After approximately 20 years, still seeing high nitrate export, due to both higher subsurface flows through soil area and higher nutrient production

- However there are some differences between harvesting and MPB mortality
    - MPB mortality will have a delayed response as opposed to harvesting
    - Litter inputs will have lower N content
    - Soil abiotic changes will be less than those from harvesting
    - Regeneration is expected to have some influence on nutrient uptake and soil moisture

- Looking at a study in Wyoming in lodgepole pine stands to determine if understory regeneration may have the ability to reduce N losses
    - If small gaps are created from MPB mortality, than residual stands may be able to compensate, roots from surrounding trees may be able to move into small gaps and uptake nutrients
    - However, if large gaps are created, residual stands probably wouldn't be able to compensate
        - Study found that N leaching was higher in larger gaps and nitrification (nutrient turnover), although low in small gaps, was stimulated by moist, warmer soil in large gaps

<u>Management Response???</u>

- Have little info on post-outbreak and post-salvage regen
- Currently, science is focusing on Best Management Practices
    - It is well documented that streamside buffers are effective at stopping overland flow
        - On typical soils, a 100' buffer stops 80% of sediment on slopes < 40%
    - Buffers limit near stream physical disturbance, thus reducing total suspended solids
    - Harvesting without buffers will increase exposed soil, decrease stream cross-sectional area, and increase suspended sediment
- Have critical unknowns with buffers of dead trees
    - Windthrow negates streambank protection
    - Windthrow is not a significant source of sediment
    - Sediment storage may actually increase with time from windthrow

Deborah Martin - Post Fire Hydrology and Water Quality Effects

Outline of presentation

Highlight hydrologic response of burned watersheds compared to unburned watersheds
Discuss potential water quality effects of fire

Fires effects on water resources within land management units

- On-site effects

    - Critical habitat
    - Threatened and endangered species
    - Water supplies
- Off-site effects
    - Water supplies

Burned watersheds encourage surface runoff

- A rainfall intensity of ½" per hour over a 30 minute period will initiate runoff
- Loss of soil cover, in terms of storage and protection from burns, encourages surface runoff
- Surface sealing and fire induced water repellency also encourage surface runoff

Unburned watersheds, water is stored in canopies, litter and duff, and soil
Burned watersheds ash will store water….until it is gone from the system

Burns transform flow from subsurface to surface, resulting in runoff, erosion, and deposition

Examples of post fire erosional styles in Colorado

- Granitic (Buffalo Creek fire) – see channel widening
- Sedimentary (Missionary Ridge fire) – saw huge debris flows

Post fire effects: Space and time

- Flooding, erosion, and deposition can also happen downstream ob burned areas (OFF-SITE EFFECTS)
- Buffalo Creek Fire – saw debris/sediment travel 11 miles downstream along the North Fork South Platte River and 3 miles downstream along the South Platte River to end up in the Strontia Springs Reservoir.
    - 1/3 of sediment is in the reservoir, 2/3 of sediment is still in the watersheds
- Effects of fire on peak flows persist for 4-10 years, can be 0-900 times greater than peak flows in unburned watersheds
- Other effects may last a lot longer!

Water quality effects of fire

- Gasses – inputs of particulates and gasses while the fire is burning
- Sediment – has MAJOR WATER QUALITY EFFECTS
- Fire retardant/fire suppression chemicals has effects
- Ash (another major issue) and partially burned organic matter also has an effect on water quality

Fires also impact aquatic environments

- Increase solar radiation and water temperatures
- Ash has the potential to change water chemistry
- Increased erosion and sedimentation
- Increased water yields

Current Project: USGS Colorado Front Range Demonstration Project in Grand County

- Performing a geographic inventory and assessment
    - Baseline hazards assessment (see figure in .ppt presentation)
        - Landcover mapping
            - Bark beetle and tree mortality
        - Values at Risk
            - Structure identification
            - Critical infrastructure
            - Water quality and availability
        - Slopes at Risk of debris flow
            - Greater than 30% slope

The Next Forest

Lead panelist: Merrill Kaufmann (TNC)
Panelist: Jim Thinnes (USFS R2)
Panelist: Linda Joyce (RMRS)
Panelist: Mike Babler (TNC)

Jim Thinnes – The Next Forest: A Silviculturist's Perspective

Influencing factors on the next forest

- Site Potential
  - Climax lodgepole pine
  - Seral lodgepole pine
- Composition and Structure
  - Tree Size, species, and density
  - Even-aged or Uneven-aged
- Disturbance
  - Beetle only
  - Harvest
  - Fire

Site Potential

- Climax lodgepole pine

Composition

- Mature even-aged lodgepole stands – expect nearly 100% mortality
- Young lodgepole stands – most trees under 5" at stump should (hopefully) survive
- Mixed species – expect mortality in large lodgepole pine, but release in other species…may see additional aspen sprouts in areas with aspen

Structure

- Overstory lodgepole
  - Expect nearly 100% mortality
  - Understory will release and most is expected to survive
  - Expect new regeneration in most stands

Stocking

- In current epidemic, density doesn't seem to matter; however, in typical outbreaks density is important

Disturbance

- Beetle Only
  - Red needles first year of infestation, will fall off by 2nd year
  - Lots of snags for 5-10 years, begin to fall within 5-10 years
  - Regeneration expected within 5 years

    - Future forest will have regeneration growing through downed logs…..HIGH FUEL LOADS!
- Harvested Areas
    - Most snags will be felled
    - Relatively few downed logs
    - Potential for large landing or slash piles
    - Good Regeneration - will be similar to non-harvested areas
    - Future forest will have regeneration with relatively light fuel loads
- Fire
    - Timing is important – when fire comes through….will it kill the regen??
    - Most fine fuels will be consumed
    - Snags will char, but remain standing….will fall similar to those in unburned areas
    - Expect good regeneration in most areas
    - Future forest will have fuel loads somewhere in between those of the beetle only scenario and those of the harvested areas scenario

Social Desires
- Collaboration
- Land Management Plan Goals and Objectives
- Desired future conditions

Management Options
- Intensive management
    - Planting
    - Non-commercial thinning/fuel breaks
    - Timber management (even-aged/uneven-aged stands)
- Prescribed natural fire
- Allow natural successional pathways to occur

Landscape Considerations
- Provide diversity at the landscape scale
- Our desires exceed our capacity to manage the landscape (i.e. most areas will not be treated or have active mgmt)
- Need to consider cost effective treatment methods and maximize available funds
- Potential to use different treatment methods across the landscape, no standard prescription exists
- Need to prioritized treatment areas

Linda Joyce – Climate Change: Reframing Natural Resource Management Strategies

Outline of presentation
- Climate is changing
- Plant, animals, ecosystems are responding
- Future climate will be warmer
- Adaptation to a changing climate

In the past, an unusual weather related condition added stress to the ecosystem, and required a management response

- Rain and snow events in Yosemite Valley created extreme unseasonal flooding
- An ice storm in Canada in 1998 dropped huge pylons that the electrical grid was dependant on
- Fires in the west
- Wind storms from North Dakota to Maine
- Dieback of pinyon-juniper woodlands in the southwest due to insects and drought
- Changing precipitation and air quality measurements

Weather versus Climate

- Weather is the state of the atmosphere now
- Climate – mean and variability of weather – temperature and precipitation – over a period of time in a particular geographic region.
- Climate is long term and requires really long records!

Climate is experiencing a warming trend over most of the US, but has warmed most in the North and in the West.

- Changes in temperature of 4°F have occurred in Canada, California, and Nevada
- Observing an earlier onset of spring snowmelt and less snowpack
    - Last three years, experienced 40-60% decrease in snowpack
    - Peak runoff across the west is occurring 1-3 weeks earlier
- Looking at monthly average minimum temperatures for 1949-2004
    - Experiencing warmer winters, snow setting later in November (creating problems for ski areas)
    - Experiencing a big warm up in January and in March
- Altered disturbance regimes
    - Larger more frequent wildfires since the 1980's
    - Longer wildfire durations
    - Linger wildfire seasons
    - Strongly associated with increased spring and summer temperatures and earlier spring snowmelt

Observed responses of plants, animals, and ecosystems to observed changes in climate

- Phenological Changes
    - Plants are greening up earlier
    - Egg-laying form NA tree swallows is occurring earlier

    - Robins are arriving earlier
    - The Yellow-bellied marmot is emerging earlier
    - Hibernation patterns are being affected
- Breeding changes
- Range of distributions shifts – example, the Sachem Skipper Butterfly has shifted Northward approximately 500km over the last 50 years
- Community changes
- Ecosystem process changes
- Invasive plant species are taking advantage of the excess carbon in the atmosphere, doubling and in some cases tripling biomass

Under all scenarios, the next 100 years will likely be warmer!

Adapting to climate change

- Do nothing – no advance planning
- React after disturbance or extreme events
- Be Proactive – plan in advance

- Create and increase resistance to impacts of climate change – SHORT TERM management action
    - Isolate, protect, and prepare high valued resources
    - Likely only possible for the short term high value projects
- Create Resilience to ongoing changes and climate related disturbances – SHORT TERM
    - Reduce and minimize stress within habitats; build in surpluses so that the system can return to a prior condition after disturbance
- Respond to climate influences – LONG TERM
    - Use a mix of management options
    - Anticipate and plan for surprise threshold effects
    - Expand genetic diversity guidelines
    - Assist animals with their migration
    - Promote porous landscapes (larger mgmt unit sizes, continuous riparian zones, appropriate fire presence)
    - Establish neo-native plants
    - Experiment with refugia
    - Use redundancy (plantations….)
- Realign conditions to current dynamics
    - For systems far out of the range of natural variability
    - Colorado River Allocations and Climate?????

Mitigation -

- Sequester greenhouse gases in the ecosystem
- Reduce greenhouse gas emissions

Mike Babler – Future Forest

Mission of the Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

By **2015**, The Nature Conservancy will work with others to ensure the effective conservation of places that represent at least 10% of every major habitat type on earth.

TNC's Global Forest Partnership – works to advance responsible forest management practices, high-impact conservation transactions, and public policies

TNC's Global Fire Initiative – develops solutions that allow fire to play a role in places where in benefits nature and keep it out of places where it is destructive

Lots of different interests drive management decisions and help us determine what is acceptable!

- Take, for example, a lodgepole pine habitat which has a range of biodiversity values. People in the natural resources profession may have a different view from that of the public on what the historic range of variability for lodgepole pine is.
- This is why collaboration is required.

Advantages and challenges of collaboration

- Advantages
  - Focus on the big picture – i.e., system changes vs. acre-by-acre conservation
  - Focus on overarching issues vs. specific points of policy
  - Create broad constituency and political momentum
- Challenges
  - It is timely and costly
  - Requires engagement beyond direct biodiversity issues
  - Big challenge – translating recommendations to results on the ground

Front Range round table

- 60% of the Front Range is private
- Got communities behind restoration projects (community engagement)
- Came up with recommendations, then prioritized which direction to go in (vision & roadmap)
- Finding people are more than willing to get stuff treated, but no industry

In order to make management decisions and determine what is acceptable, we must first determine what is at risk!

Merrill Kaufmann – Future Forests in Context

- Getting the ecology right and doing the best we can –
    - Do we have lodgepole pine ecology right?
    - How do we apply fundamental lodgepole pine ecology in the conditions that we have? Clearly, both climax and seral lodgepole pine conditions exist
    - Do we have a distorted view of how much pure lodgepole pine exists in Colorado? Is it possible that we have influenced this with legacy management?
- Adapting management to advancing knowledge as it emerges
- Collaborating is critical, even though it can be very challenging

Achieving ecosystem sustainability (make sure to look at the powerpoint for a good visual)

- Every piece of land has some sort of ecological capability
- Our decisions are based on what we deem as socially acceptable
- Then there is economic feasibility
- We are not in charge of what is socially acceptable and economically feasible

Adaptive Management (again check out powerpoint for a good visual)

- It is possible to get stuck in the plan and act mode
- However, we need to monitor and evaluate and then move forward with the knowledge gained

Collaborative Process

- Need to develop a capacity to collaborate
- Every person frames problems differently (perception is reality) – we need to recognize that, which then will allow for some degree of mutual trust
- Collaboration requires developing a common language, having common goals, and developing partnerships – this then gives us some capacity of collective action!
- Nothing about the collaborative process is linear!!!

Challenges for the future forest

- Collaboratively and continually
    - Improve the science story in general, but also for lodgepole pine (we have for pinyon-juniper and ponderosa pine)
    - Cross-walk science and management – an absolute must!
    - Develop early and inclusive stakeholder and partner relationships